Near Death Experiences: Determining the Neuroanatomical Pathways by Experiential Patterns and Simulation In Experimental Settings

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The history of science has been more than the pursuit of the unknown. The major consequence of scientific discovery has been the translation of a set of popular (qualitative) observations into explanations that are compatible with more precise (quantitative) measurements. These explanations have rarely reflected the contemporary options. Often, the explanations for the fundamental patterns of human experience involve mechanisms and processes that are beyond the limits of casual interpretation. What has appeared to have been the obvious (perceptual) cause-effect has rarely been the actual etiology (Persinger & Lafreniere, 1977).

One classic example was the common sense conclusion that the sun rotates around the earth because the former is perceived to move daily through the sky. Copernican theory offered another more accurate explanation that was based upon additional more quantitative data. A more contemporary phenomenon involves odd, aerial luminosities. The casual conclusions have been that because: 1) the odd lights *apparently* violate known physical principles, and 2) modern human technology cannot simulate the phenomena these odd lights (by conceptual default) are extraterrestrial craft or artifacts of delusional observers. However once quantitative analyses of these phenomena were completed an unanticipated explanation emerged: most of these odd lights are natural phenomena that are coupled to geophysical processes (Derr & Persinger, 1986; Persinger, 1990).

Predictions of the future are coupled to the progressions of the past. One compelling pattern, that is apparent to any historian of science, has been the demystification of Nature. The Copernican revolution removed the earth as the center of the universe. The Darwinian perspective placed the human species within a longer and less unique temporal context. As if the proclivity of the human species to engage incessantly in war was not sufficient evidence, the insights of Freud eroded the proposition of any unique or divine rationality within the human species. The history of science has seen a consistent shift from egocentrism to allocentrism.

The last major egocentric conviction that is held by most members of our species involves the existence of the sense of self. Most human beings believe, suspect or wish that this sense of personal consciousness is infinite and consequently extends beyond biological death. The anticipation of the dissolution of the sense of self or death (which is in general an aversive experience) generates significant existential anxiety whose intensity often increases as a

function of age during adulthood. The removal of the anxiety about the dissolution of the self can only occur if it is associated cognitively with a concept that implies infinity (no end or death and hence no apprehension) and preferably omnipotence. Consequently there is often an intricate subjective relationship between the sense of self, survival of death, beliefs in god and religious convictions.

These intricate associations have in large part determined human behavior. Any explicit or implicit threat to the validity of the culture's god (or religious) beliefs is sufficient to generate war and the personal conviction that others should be slaughtered in order to defend the cultural belief. When the fabric of god beliefs begins to unravel, the anxiety evoked by the potential loss of the sense of self is sufficient to generate almost any behavior that will minimize this apprehension.

The consequences of brief (a few minutes) religious experiences [whose themes are primarily mystical or paranormal phenomena but are simply interpreted within a religious tradition] change forever people's behavior and their sense of self. When one considers the brevity of the intervention compared to the pervasiveness of its effect, even the most successful strategies and tactics of clinical psychology and psychiatry are diminutive. If we could understand the neurocognitive process by which these experiences occur and implement them within clinical settings, we could modify the human sense of self more effectively.

Near-death experiences are an optimal phenomenological laboratory (Persinger, 1987) in which to investigate hypotheses such as: "does the sense of self exist independent of the body?" or "do the cross-cultural similarities in NDEs simply reflect the fact that the approximately 5 billion human brains that occupy this planet have much more microstructural similarity than social differences?".

Modern Neuroscience and Neurocognitive Correlates

One of the fundamental principles of modern neuroscience is that those portions of the brain that are most metabolically active at any given time will determine the matrix of subjective experiences. They may be the direct consequences of exogenous stimuli (Phelps & Mazziotta, 1985). For example when the normal person listens only to a melody, the right superior temporal lobe may be prefentially activated over the baseline activity of the entire brain. The display of declarative memory is associated with enhanced glucose utilization within the hippocampal formation and adjacent temporal lobe.

However intrinsic, spontaneous stimulation of specific brain regions is also associated with specific subjective experiences. The content of the experiences reported by complex partial epileptic (temporal lobe) patients reflects the structural (three-dimensional) location of the paroxysmal population of neurons (Horowitz & Adams, 1970). If the activated focus is within the right fusiform (occipitotemporal) region, the person may experience human faces or visuospatial patterns; if the activated focus is within the left superior temporal gyrus, the experience may involve complicated human syntax (as if a voice is talking in the head). If the activity occurs within the vigilance-mediating region of the right parahippocampus, the experience could involve panic or fear.

Within the last ten years, we (the Laurentian University Neuroscience Group) have been developing the concept of neurophenomenology. Its central premise is that all human experience, even mystical perceptions, paranormal phenomena and religious convictions, emerges from patterns of neuronal activity. We have not focused upon the insoluble philosophical arguments such as "does god exist" or "are paranormal/mystical experiences really true." Instead, we have asked two questions: "What portions of the brain are mediating these powerful human experiences?" and "Can we simulate these experiences by inducing

weak, biopattern-relevant electromagnetic fields within the human brain?"

One of the hypotheses that has originated from this approach is that specific stimuli should stimulate specific neuronal pathways. All normal people (brains) should report similar themes when a particular region is activated while the details of the narrative would be a function of the individual's reinforcement history. For example, focal electromagnetic stimulation of and current induction within the anterior portions of the transverse gyrus of the temporal lobes (vestibular region) should be associated with themes of vertigo and visual clouding (Crosby, Humphrey and Lauer, 1962).

Chemical stimuli, including the absence of critical elements such as oxygen, also affect preferred neuroanatomical pathways that contain shared receptor characteristics. For example, we (Persinger, Bureau, Kostakos, Peredery and Falter, 1993) have shown that (like hypoxia) lithium enhancement of muscarinic receptor agonism within the rat brain generates predictable activity within the same structures throughout the thalamus, limbic system and cerebral cortex; their recruitment over time follows a specific serial order. Primary structures involve the entorhinal (parahippocampal) cortices, hippocampus (CA1), specific amygdaloid nuclei (while the central nucleus and extended amygdala are never damaged), the lateral thalamic nuclei (analog of the pulvinar) and the mediodorsal thalamic group. When the activity is not contained or self-limiting, excitotoxic damage occurs that permanently alters the behavior of the animal.

Vectorial Hemisphericity. The results of contemporary neuroscience strongly suggest that domains of subjective experiences and the sense of self emerge at the spatial and temporal increments that involve the mediation of electromagnetic patterns by their chemical equivalents through the synapse or its subcomponents: the receptor. Consequently, specific (psychiatric) drugs that affect synaptic (receptor) activity can significantly modify neurocognitive states.

However the neurostructural substrate of the sense of self is more subtle. Kate Makarec and I (Persinger & Makarec, 1993; 1992) have suggested, as have others (Edelman, 1989; Jaynes, 1976; MacLean, 1990), that the human sense of self is a highly linguistic phenomena that involves traditional left hemispheric processes (the term "traditional" is important because statistical theory argues that these processes could be spatially localized in the opposite hemisphere for a small portion of the population). This intimate relationship between the sense of self and language is assumed to be one of the major reasons that existential anxiety and extreme aggressive behaviors are frequently generated when one's language base or cultural (language) tradition are threatened. Activation of left hemispheric processes are important for "awareness", particularly self-awareness. When this process is transiently disrupted, such as during paroxysmal discharges around dominant (primarily left) posterior hemispheric foci, dissociation occurs (Devinsky, Putnam, Grafman, Bromfield & Theodore, 1989).

Because the essential lexicon (or neurocognitive substrate) for language predominately involves the left temporoparietal region one would expect the experience of the sense of self to be most strongly correlated with the normal activity of this region. On the other hand, beliefs about the sense self, which involve a significant amount of organization of both the interoceptive (experiences) and the exteroceptive input, would preferentially involve the prefrontal regions. This is not a new concept since a reciprocal relationship between delusions (extreme beliefs) and hallucinations (intense experiences) has been shown in other neurocognitive contexts.

The concept of vectorial hemisphericity (Persinger, 1993a) also predicts that there should be the right hemispheric equivalent of the sense of self. Because traditional right hemispheric processes exhibit relatively meager linguistic capacity, this right hemispheric sense of self should exhibit minimal "awareness". The major structural inter-

faces between the two hemispheres are the anterior commissure and the corpus callosum. Under normal conditions the latter massive 250 million fiber system appears to restrict the simultaneous intercalation of pattern processing between most regions of the two hemispheres through a rich array of interhemispheric inhibitory collaterals.

However when there is a significant mismatch of metabolic activity between the two hemispheres or where there is mild disinhibition in this inhibitory pathway, intercalation can occur. According to the vectorial hemisphericity hypothesis, the intrusion of the right hemispheric (primarily temporoparietal) equivalent of the sense of self into the left hemisphere is experienced as a sense of a presence or of a humanoid entity. This sense of a presence is often attributed to mystical or religious origins, depending upon the culture.

Although the temporoparietal-intercallosal interactions mediate many of the cognitive experiences, the mesiobasal portions (amygdala, extended amygdala and hippocampus) of the brain and the adjacent limbic cortices mediate the affective (arousal; pleasant-aversive) dimensions of these experiences. Direct stimulation of the temporoparietal region by the ipsilateral (same side) mesiobasal temporal and adjacent limbic region can be associated with intense vigilance (e.g., fear, anxiety) when the right hemisphere is involved and with meaningfulness when the left hemisphere is preferentially affected.

Examples may be illustrative. We have found that people who have sustained mild brain injuries within the right temporoparietal region often exhibit neuropsychological indices that suggest regional hypometabolism. If this condition is analogous to the epileptic process (Persinger, 1993b), then intermittent brief periods of activation (hypermetabolism) could be associated with intrusion of the right hemispheric processes into the left homologous hemisphere (and hence awareness). The degree of fear or anxiety would be determined by the point of origin: initiation within the right temporoparietal cortices would be expected to be associated with less fear than indirect activation of this area by the deep mesiobasal temporal lobe structures.

Most of our patients who have hypometabolic indicators of the right parietotemporal region experience a "sensed presence" (usually in the left peripheral visual field) that is considered personal and significant. For example one young woman who exhibited a functional hypometabolic focus in the right parietal region, experienced the presence of God (sitting along the left side of her body) most nights for about 30 minutes just before she fell asleep. However, those patients who also show indicators of involvement of the right limbic structures report a sense of presence that is fearful. Another young woman who had sustained a right temporoparietal injury (with nonpathological spikes over T4), would suddenly awake terrified about 0200 to 0300 hr and sense an (evil) male presence to her left.

Intrusion from the right hemispheric equivalents during maintained elevation of left hemispheric function often generates very positive attribution. Techniques that encourage interhemispheric coherence, such as meditation, enhance the sense of presence which is often given Cosmic significance (Persinger, 1992). Creative writers, especially when they are productive during the early morning hours (0100 to 0400 hr) when right hemispheric activation is also most predominant, often experience a sense of a presence to which they attribute their inspiration. We suspect that these normal experiences may be the bases of the variant themes of the Muses (Persinger & Makarec, 1992).

The Near Death Experience

If near-death experiences are associated with the same neurocognitive processes from which the sense of self emerges, then one would expect that any stimulus condition that challenges the latter should be associated with these phenomena. Certainly one of the most understudied populations who exemplify this condition are people who have sustained mild

brain injury and who maintain their cognitive function. Individuals who sustain severe brain injury often exhibit such extreme, pervasive deficits that their capacity to compare premorbid and post-traumatic experiences are limited .

The most frequent report (by both significant others and the patient — unless a significant right prefrontal injury has also occurred) by these patients during the subsequent two years is the change in the sense of self, i.e., he or she is "not the same person". Predictably, these individuals have usually progressed through a grieving sequence: 1) responding as if nothing has happened, 2) an attempt to return to the premorbid life-style demand that generates frustration and anger, and 3) depression (Persinger, 1993b). The sense of a loss or a change in the self is generally more prevalent when the temporoparietal lobes have been involved.

Following these injuries more than 70% of the patients report enhanced sense of presence, mystical experiences or enhancement of psi capacities; the latter are more prevalent if the temporal lobe or mesiobasal structures have become electrically labile or if the person exhibits a significant enhancement of complex partial epileptic — like experiences. About 20% of these patients remember a near death experience that they couple to the time of the traumatic incident. Interestingly, a significant number of these patients have also reported *near-death like experiences just before or after they suddenly realized they were not the same person.*

Although traumatic brain injuries often involve multifocal regions, we have noted a clear pattern in the type of acquired, mild brain injury that facilitates near-death experiences. Individuals who report these experiences have sustained the type of dysfunction within the right temporoparietal and mesiobasal region that would promote periods of hypermetabolic activity and hence intrusion of unusually intense right hemispheric processes into the left hemisphere where "awareness" would occur. Patients who have sustained significant dysfunction within the equivalent region of the left hemisphere are less likely to report these experiences although obviouly, disruption of both linguistic processing and awareness may have artifactually prevented consolidation.

The content of the experience. One would expect that the function of the portions of the brain that were most activated (or disinhibited) transiently (experience occurs with the activation of neurons — not with their absence) by the damage from the mechanical trauma should predominate the neurophenomology or theme of their NDE.

Case 1. This 40 year old bilingual left handed man was intoxicated while driving a snowmobile. He struck an icebreak, was thrown from the machine, hit his head on a rock outcrop, and was knocked unconscious. As he "awoke" he heard a voice say "stop drinking liquor". Henceforth he stopped drinking and could not even tolerate the smell of any type of ethanol.

Case 2. This 21 year old girl had sustained right parietal lobe trauma (and subsequent electrical activation of the anterior right insular-orbital frontal region). She remembers her "self" suddenly looking down on her body that was connected to a heart monitor. She did not feel as if she were floating but experienced a kind of "constant vibration". The young woman suddenly felt the presence of God and knew that he was "bigger", more "powerful" and more "expansive" than anyone had imagined.

Case 3. This 18 year old girl suddenly rolled the vehicle that she was driving (the probability of a suicide attempt was very high) after an argument with peers. She felt detached and saw her dead uncle who said "different people live different ways, you live your life your way". She sustained injury over the right temporoparietal region.

The personal significance. In addition to qualifying as NDEs, these cases also reveal another central factor of these phenomena: the personal message or egocentric significance of the NDE. Structured interview with the families and patients indicated that drinking (Case 1), "the meaning of life" (Case 2) and issues over acceptance by a peer group (Case 3), had been the

central conflict during the weeks that preceded the trauma (clinically one often wonders about the magnitude of the contribution of these conflicts to the actual precipitation of the "accident").

According to the vectorial hemisphericity model, the sudden mechanically induced trauma — which would have promoted the biochemical correlate of the neurocognitive experience — facilitated intrusion of right hemispheric equivalents into left hemispheric awareness. That inferential processing could have occurred [e.g., attribution of the accident to drinking and hence drinking should be avoided] within just a few seconds is certainly within the capacity of even compromised brain function. In fact the capacity for the human brain to covertly (unconsciously) plan not only the syntax of ongoing thought processes but also to infer immediately about a perception [e.g., if you suddenly see a decapited head, then you infer (even without watching the event) that a person has been killed] is well documented (Hoffman, 1986).

More Routine NDEs. NDEs are more frequently associated with periods of hypoxia or stimuli that encourage release of CRF (corticotrophin releasing factor) and ACTH. If the temporal progression involves several minutes, such as those following mild to moderate myocardial infarctions, near drowning, or even anaesthesia during surgical operations, then the probability of more elaborate phenomenology that actually reflects the neuronal pathways is higher. Because: 1) the initial response of neurons to hypoxia (remembering that approximately half of all neurons exist on the hypoxic threshold) is to increase activity and 2) the right hemisphere, as an aggregate, enjoys more net blood flow (particularly in left handers), one would expect these conditions to encourage right hemispheric intrusions or mismatches between homologous left and right hemispheric processes.

The themes of such NDEs should reflect the functions of those neural structures which: 1) are most vulnerable to hypoxia or electrical paroxysmal activity (e.g., Sommers sector (CA1) of the hippocampus, particular amygdaloid nuclei), 2) are sensitive to altered blood flow, particularly at interfaces between arterial systems (e.g. parietotemporal regions), or 3) exhibit dense concentrations of receptor subtypes that are most vulnerable to hypoxia-induced excitotoxic activity. Considering the marked consistency of the distribution of these receptors (Mendelsohn & Paxinos, 1991) within our species (and even between species), consistent themes of NDE both between cultures and across human history should be expected and have been reported.

Assuming minimal excitotoxic death, maximal activity of the hippocampal-amygdaloid complex (and enhanced intense personal meaningfulness), and only marginal deterioration of the functional networks, one should experience intense memory images. Anomalous intercalation between the left and right parietotemporal regions would be expected to generate a separate experience of self vs the body image (an out-of-body-experience, OOBE). The predominant sense of movement (or its inference from microscopia), dream-like features, sensed presence (religious figures; dead relatives) and auditory (knowing) messages should be common themes.

The personal message of these types of NDEs is quite apparent to the experient but he or she is often reluctant to report its entirety. The impact of the personal message upon an individual's life and cognitive development is perhaps best exemplified by a well known lawyer who felt compelled to tell us his experience. When he was a young man [at about the time he was concerned significantly about what is right and what is wrong and if God existed or did not], he nearly drowned. he felt himself leave his body as it lay at the bottom of the lake and move away (although not necessarily up) into space. He experienced a diffuse light within which smaller lights were moving; they were sensed as presences and he just "knew" that they were "entities". The young man felt guilty about his life and wondered if he were to be judged by God. A face appeared that he felt was familiar but he

could not recognize it. The face said "you are your own judge", at which point he recognized that it was his own face. At a distance he saw a still brighter, richer light. Although he felt attracted to it he knew that if he entered it he would not return; a voice said 'go back, now'. The next thing he remembered was expelling water and feeling quite sick. He decided to pursue a career in law.

Possible Neuropathways for NDEs

Thematic Patterns. Although NDEs do not necessarily require an out-of-body experience (for example NDEs can be associated with apparitional reports, odd "forces" and even abduction (UFO) experiences), they are frequently and traditionally correlated with this variant of mental diplopia. An analyses of several hundred cases of subjective psi experiences (Persinger, 1974) demonstrated no statistically significant differences in the pattern of OOBEs (as a subset) that were associated with either near-death or "spontaneous" conditions. This similarity suggests that the neuropathway by which NDEs are evoked can be simulated by other less extreme physiological conditions that include personal (identity) crises.

Although there were remarkable individual differences, there were several temporoparietal themes that preceded the OOBE. The most frequent included a vestibular experience (spinning, dizziness, displacement in space, or pull by a force; a correlate of intraparietal sulcus stimulation) or a some esthetic sensation ("tingling sensation", "nothingness" or "a strange feeling"). Pure auditory experiences (music, hearing one's name called) were less frequent.

Following the antecedents, the sense of self (consciousness) was aware of the body at a distance in about 50% of the cases. About 20% of the time there was some vestibular experiences such as "being pulled by a force",, spinning, dizziness and "moving ahead through space". When the floating reference (54% of the cases) occurred, it was described as the "wind" or as "being light as a feather". The tunnel experience was not frequent. Sensed presences, often attributed to deceased relatives, were reported in about one-quarter of the cases. A bright light, often initially seen at a distance, was reported by about half of the experients. Most of them experienced a sudden "knowing" that the light was a deity (the specific description depended upon the religion).

Panoramic effects which were characterized by marked color, depth and texture and which emphasized visuospatial exaggerations were common. The details were highly individualistic and ranged from bright meadows filled with colorful birds to "a gate to a city with high walls around which space ships floated". Towards the end of the OOBE and the NDE, voices were reported (73% of the cases). The voice, often attribuated to a god or to a dead family member or friend, contained some variant of "go back, your time is not ready" or a specific instruction. In about 40% of the cases, the voice instruction was followed by the termination of the experience. Although most individuals experienced the self return to the body (i.e., reconvergence of self-body neuromatrix, if one employs Melzack's (1989) terminology) without any striking antecedent, a small percentage felt pulled by a force or experienced fear. Over all the experience was described as pleasurable by 42% of the population; however, 8% experienced the OOBE (as well as other variations of NDEs) as aversive or hellish.

Potential Mechanisms. If the vectorial hemisphericity hypothesis is valid, then the left hemispheric processes must remain within that narrow margin that promotes consciousness and memory consolidation during the NDE. Unusual intercalation between the left and right hemispheric processes would be promoted by the neurochemical correlates of the trauma.

We have been pursuing two primary hypotheses. The first is that there is something unusual about the blood flow associated with the right posterior cerebral (and rostral basilar)

arterial system during crisis or subsequent to mild brain injury. This system supplies the portions of the parietal lobe, ventral temporal lobe, limbic lobe, subcortical temporal regions and pulvinar (which is a probable source of the diffuse white light experience) with which many of the experiences are associated. Considering the differential macular (middle cerebral artery) vs peripheral visual field (posterior cerebral artery) blood supply, transient disruptions in blood supply to the latter could induce the perception of tubular or tunnel experiences as was predicted by Drab (1981).

Our second hypothesis, which is derived from our work with the specific pathways of electrical activity (and neuronal drop out) during excitotoxic or hypoxic stimulation, indicates that there is a class of receptors that is vulnerable to the biochemical stimuli that are associated with NDEs. When these stimuli are present, all the structures that display these receptors are sequentially activated as the paroxysmal activity spreads in a more or less systematic and predictable pattern. We are currently pursuing an interaction between muscarinic (cholinergic), NMDA, ACTH and possibly enkephalin systems while considering a mechanism of calcium-mediated "neurotoxicity" (Choi, 1988).

Experimental Simulation of NDE Components

If the basic phenomenological components of NDEs are predictable sequences of brain activity, then less intense and fragmented components should be evoked by weak electromagnetic stimulation of the brain if the sensory environment simulates the pre-NDE condition (during many of these conditions, normal visual and auditory input are diminished or eliminated). We, like the researchers who work with positron emission tomography (PET), have found that even in normal "quiet" rooms a significant number of neurons are committed to simply registering ambient sound and visual patterns. By removing this input, these neurons can then become responsive to subtle electromagnetic patterns.

To simulate this condition, individuals sit in the dark (wearing goggles) within an echoic chamber. Weak (50mG) electromagnetic fields, generated by a computer in order to simulate biogenic signatures (such as the pulse pattern of the amygdala), are then applied across the temporal plane (Richards, Persinger & Koren, 1993). During an approximately 20 to 30 min exposure, the subject reports his/her experiences (which are later transcribed for analysis). Before leaving the chamber, each subject completes a questionnaire that rates the frequency of fundamental themes and experiences. During the last five years, members of the Neuroscience Group have tested more than 200 volunteers.

The percentage of subjects who reported the specific domains of experiences when exposed to these eletromagnetic fields while sitting in a partial sensory-deprived setting can be seen in Table 1. The most common experiences include dizziness and tingling sensations. Out-of-body like experiences and the sense of a presence occurred in about one-quarter of the volunteers. About twice the numbers of women report the sense of a presence compared to men; we suspect that this reflects a sexual dimorphism that is coupled to the greater interhemispheric coherence of the normal female brain (hence women are more prone to right hemispheric intrusions, a process that could accommodate the higher female/male odds ratios for several domains of psychic experiences).

Table 1. Percentage of Subjects Reporting Experiences Within Experimental Simulation of NDE-like Settings (n=153)

Item	Percentage Yes
Dizzy or odd	75
Sense of Presence	30
Tingling Sensations	73
Vivid Visual Images	52
Left Body/Detached	39
Vibrations in Body	54
Inner Voice Call Name	03
Experiences Not From Own Mind	13
Odd Smells	06

Fear or Terror	32
Odd Tastes	13
As If Somewhere Else	55
Thoughts From Childhood	35
Images From a Dream	29

The temporal lobe lability (sensitivity) of the experient. Is it possible that certain brains are more prone to NDEs than are others, given the same level of stimulation? We have suspected that anomalous experiences in general are interactions between: the neurocognitive style, the demand characteristics of the setting (or the expectancy associated with it) and the stimulus trigger. If the brain is already electrically labile (which is a common correlate of creative individuals, such as writers, musicians and psychics), then anomalous experiences should be evoked by little (and more ethical) stimuli (Richards, Persinger & Koren, 1993).

These predictions have been verified empirically. People who display higher scores (obtained a week before any chamber testing) on inventories that infer complex partial epileptic-like signs and symptoms (Persinger & Makarec, 1993; Roberts, et. al., 1990) also exhibit more intense experiences of odd somesthetic experiences (rho=0.46), dream-like images (rho=0.33), vestibular sensations (rho=0.30) and out-of-body experiences (rho=0.28). The sense of a presence (rho=0.32), experience of vivid visual images (rho=0.42) and pleasant body vibrations (rho=0.41) are conspicuous associations.

Implications if the Brain is Changed by NDEs

NDEs are often associated with the types of traumas of biochemical extremes that can alter receptor densities and neuronal pathways. The critical variable involves the extent and location of the brain anomaly. Because of the remarkable reactive synaptogenesis or neuroplasticity of the mesiobasal temporal lobe structures (Sutala, Cascino, Cavazos, Parada & Ramirez, 1989), relatively minute amounts of neuronal drop out may actually encourage new synaptic connections within this region of the human brain. Inputs that have never previously converged would be integrated. If structure dictates function and microstructure dictates microfunction, then one would expect that the person may display properties and experience phenomena that were not present before the NDE.

In the tradition of Johannes Mueller, who argued that we are only aware of the states of our nerves, these new nerve nets would allow discrimination of phenomena that hereto had been ignored. The capacity to pair subtle environmental stimuli, because of enhanced sensory-limbic hyperconnectionism, is frequently found in subpopulations of temporal lobe (complex partial) epileptic patients who display electrical anomalies — similar to biological crises, within the mesiobasal portions of the temporal lobes.

If this conclusion is valid, then the NDE does not lose its significance. Isolation of the neuroanatomical substrate does not deny the NDE's validity. The fact that the NDE was experienced and remembered may be an indicator that significant "restructuring" of the portions of the brain that mediate the sense of self has occurred. Simulations of this restructuring would constitute an important and powerful tool within clinical populations.

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HEALING : BEYOND SUFFERING OR DEATH

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